February 2, 2018

Chairman Greg Walden
United States House of Representatives
Committee on Energy and Commerce
Washington, D.C. 20515

Dear Chairman Walden, Chairwoman Blackburn, Chairman Latta, and Chairman Harper,

Thank you for your inquiry regarding iPhones, batteries, and performance. We welcome this opportunity to provide additional information and clarity on this issue and to answer your questions.

Apple's recent actions related to performance of iPhones with older batteries were based on providing our customers with the best experience. In this case, that meant preventing iPhone 6 or later models from unexpectedly shutting down under certain circumstances. As we said publicly, we have never — and would never — do anything to intentionally shorten the life of any Apple product, or degrade the user experience to drive customer upgrades. Our goal has always been to create products that our customers love, and making iPhones last as long as possible is an important part of that.

We want to provide a timeline of key events that led to where we are today, as well as some technical background that we hope you will find helpful, in addition to the answers to your questions.

Timeline

In fall 2016, we received reports from a few iPhone customers whose devices were experiencing unexpected shutdowns. We found that a small number of iPhone 6s devices had batteries that contained a battery component that was exposed to controlled ambient air longer than it should have been before being assembled into battery packs. We set up a program to replace those batteries for affected iPhone 6s owners. We also discovered that other iPhones, under certain circumstances, were experiencing unexpected shutdowns.

To learn more, we did a software update that included diagnostics to help us understand whether we needed to improve the algorithms used to manage battery performance and shutdowns. An iPhone is actually designed to shut down automatically under certain conditions, such as extremely cold temperature. To an iPhone user, some of those shutdowns might seem unexpected, but they are designed to protect the device's electronics from low voltage.

After gathering and analyzing data, we issued the iOS 10.2.1 software update in January, 2017, for iPhone 6, iPhone 6 Plus, iPhone 6s, iPhone 6s Plus, and iPhone SE. Then we looked at the diagnostic data made available by the update, and it indicated that the rate of unexpected shutdowns was greatly reduced for iPhone 6 and iPhone 6s owners. In February, 2017, we updated our iOS 10.2.1 ReadMe notes to let customers know the update "improves power management during peak workloads to avoid unexpected shutdowns." We also provided a statement to several press outlets and said that we were seeing positive results from the software update. We extended the same support for iPhone 7 and iPhone 7 Plus through iOS 11.2 in December, 2017.

Technical Background

As lithium-ion batteries chemically age, their ability to hold a charge diminishes. This may result in shorter amounts of time before a device needs to be recharged. In addition, a battery's ability to provide power quickly may decrease. In order for a phone to function properly, the electronics must be able to draw on instantaneous power from the battery. One attribute that affects this instantaneous power delivery is the battery's impedance. A battery with a high impedance is unable to provide power quickly enough to the system that needs it. A battery's impedance can increase if a battery has a higher chemical age. A battery's impedance will temporarily increase at a low state of charge and in a cold temperature environment. When coupled with a higher chemical age, the impedance increase will be more significant. These are characteristics of battery chemistry that are common to all lithium-ion batteries in the industry.

We do not want our customers to experience interruptions in the use of their iPhones, whether that is making an emergency phone call, taking a picture, sharing a post, or watching the end of a close game. To address the issue of unexpected shutdowns, we are constantly working to improve battery performance. We also have developed software that dynamically manages power usage when, and only when, an iPhone is at risk of an unexpected shutdown. This power management software helps keep iPhones on when they otherwise might turn off, by balancing the demand for power with the available supply of it.

While our intention has been to give our customers the best products and the best experiences, we have apologized to our customers and, as described here, have taken a number of steps to address the complaints.

Your questions and our answers are below.

1. When and how did Apple first become aware of the need to develop an iOS software update to address instantaneous phone shutdowns attributable to battery degradation? When did Apple begin throttling iPhone processor performance through iOS software updates?

As noted above, Apple became aware, through customer interaction and our own analysis, that a small number of users were experiencing unexpected shutdowns. We first delivered this power management feature to iPhone 6, iPhone 6 Plus, iPhone 6s, iPhone 6s Plus, and iPhone SE as part of iOS 10.2.1 in January 2017.

2. Prior to installation of an iOS software update, does Apple inform users of the potential for a reduction in processor performance associated with the update? If no, why not?

Once we verified that the feature was effective in avoiding unexpected shutdowns, we updated the iOS 10.2.1 ReadMe notes in February 2017. Specifically, the iOS 10.2.1 ReadMe notes said that 10.2.1 "also improves power management during peak workloads to avoid unexpected shutdowns on iPhone."

We also made this statement to Fortune, TechCrunch, and several other media outlets on February 23, 2017:

> With iOS 10.2.1, Apple made improvements to reduce occurrences of unexpected shutdowns that a small number of users were experiencing with their iPhone. iOS 10.2.1 already has over 50% of active iOS devices upgraded and the diagnostic data we've received from upgraders shows that for this small percentage of users experiencing the issue, we're seeing a more than 80% reduction in iPhone 6s and over 70% reduction on iPhone 6 of devices unexpectedly shutting down.
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> We also added the ability for the phone to restart without needing to connect to power, if a user still encounters an unexpected shutdown. It is important to note that these unexpected shutdowns are not a safety issue, but we understand it can be an inconvenience and wanted to fix the issue as quickly as possible. If a customer has any issues with their device they can contact AppleCare.

As noted, the software update successfully reduced the incidence of unexpected shutdowns and that customers' experience with it was positive. We extended the same support to iPhone 7 and iPhone 7 Plus through iOS 11.2 in December 2017.

3. What steps, if any, is Apple taking to address potential security concerns that could develop if consumers become wary of iOS software updates that could reduce processor performance, and delay or fail to update as a result?

iOS leads the industry in software update adoption. As of January 18, 2018, 65% of devices were using iOS 11. Through compelling new features and upgrades and user

notifications, our customers have notice and incentives to update to the latest version of iOS.

In addition, iOS 11.3 will add new features to give customers greater visibility into the health of their iPhone's battery. The new software update will recommend if a battery needs to be serviced. It also will allow customers to see whether the power management feature that dynamically manages maximum performance to prevent unexpected shutdowns is on and they can choose to turn it off. These features will be listed in the ReadMe notes that customers see prior to installing an update. We will also make users aware through the press.

4. Does Apple utilize processor performance throttling for iPhone models that predate the iPhone 6? If so, please list the models. If not, why not?

Older iPhone models such as iPhone 5s and earlier have different system power demands than newer iPhone models and so did not experience the same issue.

5. Does Apple currently utilize processor performance throttling for iPhone 8 and iPhone X models that are operating with reduced battery capacities? If no, why not?

All iPhone models have basic performance management to ensure that the battery and overall system operates as designed and internal components are protected. And, in the case of hot temperature, the performance management ensures that the device stays within safety limits. Such basic performance management is required for safety and expected function, and it cannot be turned off.

iPhone 8, iPhone 8 Plus, and iPhone X models include hardware updates that allow a more advanced performance management system that more precisely allows iOS to anticipate and avoid an unexpected shutdown.

6. Aside from replacing the battery, what alternatives, if any, are available to consumers whose iPhones may have their processors speeds throttled attributable to an iOS update? In the event there are alternatives for these consumers, how does Apple communicate them?

The upcoming iOS 11.3 software update will allow customers to see if the power management feature related to unexpected shutdowns is on, and it will allow customers to turn it off.

7. What battery-related information will be provided to consumers in the forthcoming iOS update, referenced in Apple's December 28, 2017 statement? How will this information be provided? When does Apple anticipate releasing this update?

As we recently announced, iOS 11.3 will add new features to give customers greater visibility into the health of their iPhone's battery. The new software update will recommend if a battery needs to be serviced. It also will allow customers to see if the power management feature related to unexpected shutdowns are on, and it will allow customers to turn it off. The developer update will be available this month, and the user update will be available this spring. Each software update lists the features, fixes, and other improvements that are in the release.

In addition, we have an Apple Support article with information to help customers understand more about how their iPhone batteries work. It also includes tips to maximize battery performance.

8. Has Apple attempted to prevent battery-induced instantaneous iPhone shutdowns through means other than processor throttling through iOS updates? If so, please identify all alternative methods Apple has explored. If no, why not?

All iPhone models have basic performance management to allow the devices to function as designed. This includes handling of extreme heat or cold, as well as voltage management, so that internal components are not overburdened by performance needs. Such basic performance management is required for safety and expected function, and it cannot be turned off.

9. Does Apple have a team dedicated to addressing battery-induced instantaneous iPhone shutdowns? If so, how many full-time employees are assigned to this issue?

Apple has both hardware and software product development teams comprised of many individuals who are dedicated to battery technology.

10. Aside from processor throttling, please describe the actions, if any, Apple is taking to remedy instantaneous iPhone shutdowns attributable to degraded batteries.

We have hardware and software research and development teams that are always working on ways to improve how iPhones manage performance.

11. How many customers are eligible to take advantage of its reduced-cost battery replacement offer, and how many does Apple anticipate will do so? Does Apple believe it will have a sufficient supply of replacement batteries to meet this demand?

This is difficult to estimate since we have not done something like this before. The program is available to anyone with an iPhone 6 or later, regardless of whether they have experienced performance issues. We wanted the battery

replacement offer to be a substantial discount, and we anticipate that anyone who is eligible for it and who wishes to take advantage of it will be able to do so. We anticipate having adequate supply and are continuing to improve repair times so that customers can get their batteries replaced in a timely manner.

12. Why did Apple choose to end the reduced cost replacement program for out-of-warranty iPhone batteries in December 2018?

We are offering the discounted replacement battery for a full year to give customers an adequate opportunity to participate. We anticipate that anyone who is eligible for this offer and who wishes to take advantage of it will be able to do so, and we anticipate having adequate supply. We will continue to assess this situation as it develops.

13. If Apple does not develop a method to prevent instantaneous iPhone shutdowns other than processor throttling by the end of 2018, will it consider extending the term of its reduced cost replacement battery program?

Yes, we will continue to assess this situation as it develops.

We appreciate your attention to this issue and the opportunity to address your questions.

Sincerely,

Cynthia C. Hogan
Vice President for Public Policy, Americas
Apple